Description of the Invention

Applicant's invention relates to a method for preparing membrane electrode assemblies (MEAs), and in particular to a method of manufacturing a proton-conducting cation-exchange electrolyte membrane for use in a membrane electrode assembly (MEA), in which atmospheric pressure plasma deposition is used to deposit catalysts such as platinum onto a polymer substrate, or a substrate including carbon cloth or carbon particles. The invention has three principal characteristics:

1) The noble metal catalyst is deposited on the membrane by discharge enhanced chemical vapor deposition (DECVD); and

2) The DECVD is carried out at atmospheric pressure, without adding noble gases to the **single mixed randomized** DECVD carrier gas/reactant stream.

3) The reactants included in a carrier gas pass directly between 2 or more electrodes

REMARKS

Claims 1, 3-9, and 11-16 are pending, and stand rejected.

Claim 1 has been amended to cite "a single mixed randomized gas stream of reactants in a carrier gas". This amendment is supported by the Diagrams, paragraph [0028], and the mixed gases supported by the "randomized ...downstream gas mixing" in paragraph [0029]. This amendment was made to even more clearly emphasize that "single mixed stream" also means randomized.

Response to the Examiner's Response to Applicant's Arguments:

Fukuda:

The Examiner maintains that "the process of Fukuda '306 will necessarily a degree of mixing at the interface between the two gases, reactant and carrier". (Page 2, 8/21/07 office action.) Applicant totally agrees with the Examiner, and it is this exact point that differentiates Applicant's claim from the Fukuda reference! While there is some minimal mixing of the gas streams at the interface, there is clearly no single randomized gas stream. The Fukuda reference has designs to specifically minimize any

turbulent flow and any mixing of the gases. Therefore, as the Examiner has pointed out, there is an interface with minimal mixing, but the mere presence of any "interface" is a clear indication of two separate phases, perhaps with a small gradient. However, it is clear that the gas phases of Fukuda are meant to remain separate, and clearly not randomized as in Applicant's claims.

The Fukuda reference clearly teaches that "the apparatus is constructed so that the reactive gas is not directly in contact with the discharge surface of the first electrode or the second electrode" (Col 3, lines 28-31). In column 15, lines 29-45 the Fukuda reference describes the workings diagramed in Figure 2. "The voltage application electrode is provided so that the electrode is surrounded with the gas paths, whereby turbulent flow is difficult to occur in the discharging space, the inert gas contacts the voltage application electrode 2, and the reactive gas contacts the surface of substrate 1. The above structure of the electrode section is such that the voltage application electrode 2 does not directly contact the reactive gas for forming a layer..."

Thus, while the Examiner may conclude that some small amount of mixing of the two gas streams may occur, it is clear from the Fukuda reference that the apparatus is designed to either totally prevent any mixing of the two gas streams (as in Figure 1), or else extreme pains are taken to minimize any mixing by limiting turbulent flow.

Meanwhile, Applicant's invention involves "the vaporized reactants and carrier gases are directed through the discharge" (page 12, para. [0025], lines 2 and 3). Applicant's do not "use a noble gas in the carrier gas to suppress arcing...there is adequate randomization of microarc location and/or downstream gas mixing." (page 14, [0029])

The Fukuda teaching of minimizing or avoiding contact and mixing of the reactive and inert gases not only fails to teach or suggest Applicant's claim limitation of a randomized gas stream, but clearly teach away from Applicant's claims. One of skill in the art would not be motivated by the "separate stream" teaching of Fukuda, to practice Applicant's claims of a "single mixed randomized gas stream".

Hammerschmidt in view Fukuda

Claims 1, 3, 5-6, and 11-14, stand rejected under 35 U.S.C. 103(a) as being

unpatentable over Hammerschmidt (US 6,010798) in view of Fukuda (US 6,849,306). These references fail to create a *prima facie* case of obviousness over Applicant's claims as amended.

The Examiner points out that one cannot show non-obviousness by attacking references individually. A *prima facie* case of obviousness requires that the cited references must teach or suggest all of the claim limitations. If one or more of Applicant's claim limitations is not taught or suggested in any of the cited references, the combination cannot be found to teach or suggest those claim limitations. The Examiner has pointed out that the Hammerschmidt reference discloses varying techniques, but those techniques are not meant to be limited to the exemplary possible techniques. However, the fact that all of the listed and exemplified techniques in Hammerschmidt are far outside of Applicant's claims, cannot make Applicant's claims obvious.

Nowhere in either the Hammerschmidt or Fukuda references is there found all of Applicant's claim elements, and therefore the combination also does not teach or suggest those elements. The fact that Hammerschmidt only teaches techniques outside of Applicant's claims demonstrates that the Hammerschmidt invention works outside of Applicant's claim limitations, and therefore does teach one of skill in the art to practice techniques not within Applicant's claim limitations.

Hammerschmidt in view Fukuda and Others:

As shown above, the Hammerschmidt reference in view of Fuduka fails to teach or suggest all of Applicant's claim limitations, in particular: A catalyst deposited on a membrane by discharge enhanced chemical vapor deposition (DECVD); at atmospheric pressure, without adding noble gases to the single mixed DECVD carrier gas/reactant stream, where the reactants included in a carrier gas pass directly between 2 or more electrodes. The Examiner then cited additional references, none of which, taken with Hammerschmidt and Fukuda, cite all of Applicant's claim limitations (as amended). Therefore, no *prima facia* case of obviousness is presented.

Hammerschmidt in view Fukuda and Schutze

Claim 4 stands rejected under 35 U.S.C. 103(a) as being unpatentable over

Hammerschmidt (US 6,010798) in view of Fukuda (US 6,849,306), further in view of Schutze. The Schutze The Schutze reference teaches a plasma jet using flowing helium. Applicant's amended claims cite a method without adding noble gases to the DECVD carrier gas. The Schutze reference not only fails to teach or suggest Applicant's claim limitation of no added noble gas, but teaches away from Applicant's claims by requiring a noble gas. The Schutze reference fails to correct the deficiencies of the other cited references, fails to teach or suggest Applicant's claim limitations, and teaches away from Applicant's claims.

Further in view of Yasumoto

Claim 7 stands rejected further in view of Yasumoto (US 2003/0096154). The Yasumoto is a secondary reference cited by the Examiner to teach the spraying of the catalyst onto the surface of the polymer electrode membrane. Applicant's do not claim a method in which a catalyst is sprayed onto a polymer electrode membrane, but rather a discharge enhanced chemical vapor deposition method. Thus the Yasumoto reference fails to teach Applicant's claims.

Further in view of Nanaumi

Claims 8-9 stand rejected under 35 U.S.C. 103(a) as being unpatebtable further in view of Nanaumi (US 2004/0180250).

The Nanaumi reference is cited to cite polymer electrolyte membrane structures. However the Nanaumi reference fails to teach or suggest Applicant's many claim limitations, and fails to correct the many deficiencies of the other references cited.

Further in view of Kamo

Claims 14 and 15 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Dearnaley (US Patent Number 6,159,533) in view of Schutze in view of Fornsel (WO 01/32949, US 6,800,336), and further in view of Kamo (US 2003/0059659). The Kamo reference is a secondary reference cited to show the use of a platinum alloy in the anode side of an electrolyte membrane. While the Kamo reference discloses a

platinum/ruthenium alloy for a fuel cell electrode, the platinum/ruthenium alloy is supported on a carbon powder, rather than directly on a membrane as claimed by Applicant. In Example 2, the platinum/ruthenium alloy is screen printed using a slurry. One in the art would not be motivated by this method alone – or in combination with the other cited reference to practice all of the limitations in Applicant's amended claims.

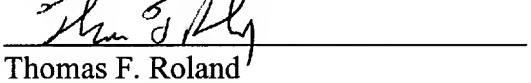
Further in view of Haug

Claim 16 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Dearnaley (US Patent Number 6,159,533) in view of Schutze in view of Fornsel (WO 01/32949, US 6,800,336), and further in view of Haug. The Haug reference is a secondary reference cited to show the deposition of multiple catalyst layers. The Haug reference demonstrates the use of a vacuum sputter deposition system for producing a PEM. The disclosure of a multiple layer of catalyst by methods teaching away from Applicant's claimed method fails to heal the defects of the cited art to present a *prima facie* case of obviousness.

Conclusion

The references cited, either alone or in combination, fail to teach or suggest all of Applicant's claim limitations, and therefore fail to present a *prima facie* case of obviousness over Applicant's amended claims. For the above reasons the present claims 1, 3-9, and 11-16 are believed by the Applicant to be novel and unobvious over the prior art, thus the claims herein should be allowable to the Applicant. Accordingly, reconsideration and allowance are requested.

Respectfully submitted,



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